

PRIORITY

Attached herewith is a copy of the application data sheet that was submitted together with the filing of the present application on November 9, 2001. Reference to claim priority to U.S. Provisional Application No. 60/302,141 filed on June 29, 2001 is made on page 1 of the application data sheet. Furthermore, included therein on the top of page 2 are instructions for amending the specification according to 35 U.S.C. 119(e). Therefore, the Undersigned believes that the Applicant has complied with 35 U.S.C. 119(e) for receiving the benefit of an earlier filing date.

PATENTABILITY OF THE CLAIMS

Claim 1 pertains to a method for inspecting a specimen by detecting electrons that scatter from the specimen. Specifically, claim 1 requires among other things setting a high pass filter to a first and then a second voltage level while detecting an electron intensity level at each setting of the high pass filter. Then "determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level". One of the many advantages of performing a method in the manner claimed is that a high pass filter is used to simply and cost effectively obtain spectral information on semiconductor wafers. (See Page 5, Lines 10-11) Claims 7, 10, 12, and 20 contain at least some of these similar limitations.

In contrast, the cited art lacks the advantages of the present invention. This is because the cited art, taken alone or in combination, fail to teach or suggest determining a differential electron intensity level in the manner claimed. Iwasaki discloses using a focused ion beam apparatus having a charged particle energy filter for measuring the potential of the surface of the sample under treatment. The energy filter includes an extraction electrode for extracting secondary electrons generated from a sample by irradiating an ion beam thereon and a grid electrode for discriminating the secondary electrons based on their energy levels. (See Abstract) By monitoring the potential of the grid electrode 45, the potential of the sample can be measured. Iwasaki further teaches adjusting the potential of the grid electrode 45 so that a detected signal level becomes the same as that of the reference signal. Thereafter, the reference signal level of the comparator 50 is changed to find a potential of the grid at which a constant intensity of the secondary electrons is obtained. This potential of the grid corresponds to the surface potential of the sample. (See Column 3, Lines 46-65) Although the Examiner noted that Iwasaki teaches

“detecting” and “discriminating” secondary electrons (col. 3, lines 43-50, col. 4, lines 31-35, and claim 1), which is akin to “differentiating” the secondary electrons, Iwasaki does not teach or suggest “determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level” by setting a high pass filter to a first and then a second voltage level while detecting an electron intensity level at each setting of the high pass filter.

With respect to Lo et al., Lo et al. merely teaches a voltage contrast method for semiconductor inspection using a low voltage particle beam. Parameters of inspection tool 10 are optimized to improve image uniformity and contrast, particularly voltage contrast. (See Abstract) However, Lo et al. neither teaches nor suggests “determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level” by setting a high pass filter to a first and then a second voltage level while detecting an electron intensity level at each setting of the high pass filter. Therefore, it is respectfully submitted that claims 1, 7, 10, 12, and 20 are patentably distinct from the cited art.

The Examiner’s rejections of the dependent claims are respectfully traversed. Claims 2-6, 8, 9, 11, and 13-19 each depend either directly or indirectly from independent claims 1, 7, 10, 12, or 20 and, therefore, are respectfully submitted to be patentable over cited art for at least the reasons set forth above with respect to claims 1, 7, 10, 12, or 20. Further, the dependent claims require additional elements that when considered in context of the claimed inventions further patentably distinguish the invention from the cited art.

NEW CLAIMS

New Claims 22 and 23 are believed to be patentable over the art of record for much the same reasons as claim 1. Claim 22 has been added to explicitly cover embodiments where electron intensity level corresponds to the measured number of scattered electrons. New claim 23 is intended to more broadly recite the concept of where the first and second voltage levels are predetermined

SUMMARY

It is respectfully submitted that all pending claims are allowable and that this case is now in condition for allowance. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

If any fees are due in connection with the filing of this Amendment, the Commissioner is authorized to deduct such fees from the undersigned's Deposit Account No. 50-0388 (Order No. **KLA1P035**).

Respectfully submitted,
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

20. (Amended Once) An inspection system comprising:

a beam generator for generating an electron beam;

a detector having a high pass filter for detecting scattered electrons; and

a controller arranged to:

set the high pass filter at a first voltage level such that the detector detects the scattered electrons with the high pass filter while set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons that is used to generate a first image of the inspected region; **[and]**

set the high pass filter at a second voltage level such that the detector detects the scattered electrons with the high pass filter while set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons that is used to generate a second image of the inspected region;

determine a first differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, wherein the first differential electron intensity level is the electron intensity level in an energy window between the first and second voltage level; and

generate a first resulting image of the inspected region from the differential electron intensity level.

APPENDIX: CURRENTLY PENDING CLAIMS

1. A method for inspecting a specimen by detecting electrons that scatter from the specimen comprising:

scanning and directing an electron beam to irradiate a spot on the specimen, the electron beam causing the electrons to scatter from the irradiated spot on the specimen;

setting a high pass filter at a first voltage level;

detecting the scattered electrons with the high pass filter that is set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons;

setting the high pass filter at a second voltage level;

detecting the scattered electrons with the high pass filter that is set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons;

determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, whereby the differential electron intensity level is the electron intensity level in an energy window between the first and second voltage level; and

repeating each of the setting, detecting and determining operations to obtain additional differential electron intensity levels for successively irradiated spots along the scanned specimen, whereby the plurality of determined differential electron intensity levels provide inspection information about the specimen.

2. A method as recited in claim 1 wherein the plurality of differential electron intensity levels are used to generate a scanning electron image of the specimen.

3. A method as recited in claim 1 wherein the first and second voltage levels are set to encompass an energy spectrum wherein the respective scattered electrons that are detected are secondary electrons.

4. A method as recited in claim 3 wherein the first and second voltage levels are further set to encompass an energy spectrum such that secondary electrons displaying high mean free paths are not collected and secondary electrons displaying relatively lower mean free paths are detected, whereby the resolution of the inspection information is increased.

5. A method as recited in claim 1 wherein the first and second voltage levels are set to encompass an energy spectrum such that scattered electrons displaying high mean free paths are

not collected and scattered electrons displaying relatively lower mean free paths are detected, whereby the resolution of the inspection information is increased.

6. A method as recited in claim 1 wherein the specimen is a semiconductor wafer and the inspection information is used to measure a critical dimension on the semiconductor wafer.

7. A method for determining an interface between a first material and a second material on a specimen by detecting electrons that scatter from the specimen, the method comprising:

scanning and directing an electron beam to irradiate a spot on the specimen, the electron beam causing the electrons to scatter from the irradiated spot on the specimen;

setting a high pass filter at a first voltage level;

detecting the scattered electrons with the high pass filter that is set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons;

setting the high pass filter at a second voltage level;

detecting the scattered electrons with the high pass filter that is set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons;

determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, the first voltage and the second voltage setting the limits to an electron energy range within which the first and second material emit different electron intensity levels;

repeating each of the setting, detecting and determining operations to obtain additional differential electron intensity levels for successively irradiated spots along the scanned specimen; and

evaluating each of the additional differential electron intensity levels that are determined for a change in intensity levels between subsequently determined differential electron intensity levels, whereby the change between subsequently determined differential electron intensity levels indicates an interface between the first and second materials.

8. A method as recited in claim 7 wherein the plurality of differential electron intensity levels are used to generate a scanning electron image of the specimen.

9. A method as recited in claim 7 wherein the first and second voltage levels are set to encompass an energy spectrum wherein the respective scattered electrons that are detected are secondary electrons.

10. A method for performing spectroscopy on a specimen by detecting electrons that scatter from the specimen comprising:

directing an electron beam to irradiate a spot on the specimen, the electron beam causing the electrons to scatter from the irradiated spot on the specimen;

setting a high pass filter at a first voltage level;

detecting the scattered electrons with the high pass filter that is set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons;

setting the high pass filter at a second voltage level;

detecting the scattered electrons with the high pass filter that is set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons;

determining a differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, whereby the differential electron intensity level is the electron intensity level in an energy window between the first and second voltage level; and

repeating each of the setting, detecting and determining operations to obtain additional differential electron intensity levels such that during each repeated cycle of setting, detecting and determining, the first voltage level is set to the second voltage level and the second voltage level is increased a determined increment, each of the successively determined differential electron intensity levels providing information as to an electron intensity spectrum for the specimen.

11. A method as recited in claim 10 wherein the first voltage level is initially set at zero and the final setting of the second voltage level is equal to the voltage level of the electron beam.

12. A method for inspecting a specimen by detecting electrons that scatter from the specimen comprising:

directing an electron beam to irradiate an inspected region on the specimen, the electron beam causing the electrons to scatter from the inspected region;

setting a high pass filter at a first voltage level;

detecting the scattered electrons with the high pass filter while set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons that is used to generate a first image of the inspected region;

setting the high pass filter at a second voltage level;

detecting the scattered electrons with the high pass filter while set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons that is used to generate a second image of the inspected region;

determining a first differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, wherein the first differential electron intensity level is the electron intensity level in an energy window between the first and second voltage level; and

generating a first resulting image of the inspected region from the differential electron intensity level.

13. A method as recited in claim 12 further comprising sequentially repeating the operations of claim 12 wherein refreshed differential electron intensity levels and respective refreshed resulting images of the inspected region are continuously generated.

14. A method as recited in claim 13 wherein the refreshed resulting images are generated substantially immediately after the previously generated refreshed resulting image so that the specimen can be viewed substantially in real-time.

15. A method as recited in claim 13 wherein the repeated operation of setting the high pass filter at the first voltage level is performed simultaneously with the operation of determining the first differential electron intensity level.

16. A method as recited in claim 13 further comprising:

scanning the electron beam such that the inspected region covers a new area on the specimen, the refreshed resulting images thereby representing images of the new area covered by the inspected region.

17. A method as recited in claim 12 wherein the first and second voltage levels are set to encompass an energy spectrum wherein the respective scattered electrons that are detected are secondary electrons.

18. A method as recited in claim 12 wherein the first and second voltage levels are set to encompass an energy spectrum such that scattered electrons displaying high mean free paths are not collected and scattered electrons displaying relatively lower mean free paths are detected, whereby the resolution of the inspection information is increased.

19. A method as recited in claim 12 wherein the specimen is a semiconductor wafer and the inspection information is used to measure a critical dimension on the semiconductor wafer.

20. (Amended Once) An inspection system comprising:

a beam generator for generating an electron beam;

a detector having a high pass filter for detecting scattered electrons; and

a controller arranged to:

set the high pass filter at a first voltage level such that the detector detects the scattered electrons with the high pass filter while set at the first voltage level, the high pass filter detecting a first electron intensity level of the scattered electrons that is used to generate a first image of the inspected region;

set the high pass filter at a second voltage level such that the detector detects the scattered electrons with the high pass filter while set at the second voltage level, the high pass filter detecting a second electron intensity level of the scattered electrons that is used to generate a second image of the inspected region;

determine a first differential electron intensity level, which is the difference between the first electron intensity level and the second electron intensity level, wherein the first differential electron intensity level is the electron intensity level in an energy window between the first and second voltage level; and

generate a first resulting image of the inspected region from the differential electron intensity level.

21. (Canceled)

22. (New) A method as recited in claim 1, wherein the electron intensity level corresponds to the measured number of scattered electrons.

23. (New) A method as recited in claim 1, wherein the first and second voltage levels are predetermined.